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(71) Applicants
Ranks Hovis McDougall plc,
(Great Britain),
King Edward House,
PO Box 178,
27/30 King Edward Court,
Windsor,
Berks SL4 1TL.
(72) Inventors
Peter Richard Dawe,
Una Yvette Thompson.
(74) Agent and/or Address for Service
Urquhart-Dykes and Lord,
47 Marylebone Lane,
London W1M 6DL.

(54) **Starch-based expandable snack products**

(57) A process for making starch-based foodstuffs or half products therefor using a pasta extruder from a formulation in which the starch component comprises free gelatinised starch. The formulation is extruded under a pressure of between 80 to 130 kg/cm^2 and a pre-die temperature of 50° to 70°C under conditions at which minimum gelatinisation of the native starch occurs.

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This print embodies corrections made under Section 117(1) of the Patents Act 1977.

SPECIFICATION

A foodstuff and a half product therefor

The present invention relates to the production of a foodstuff in the form of snack products and half products using equipment normally used for the manufacture of pasta.

The snack products to which this invention relates are those consisting of materials that are expanded normally by frying, to give a puffed structure with desirable textures, flavours, and shapes. "Half products" refers to the products which are later expanded to give the final snack products.

There is considerable prior art on the manufacture of snack products and half products. It is well known that equipment for manufacturing pasta can be used to make half products, provided significant constraints on the nature of the raw materials used are respected.

There has been considerable detail given concerning the requirements of the raw materials to be used in snack manufacture using pasta equipment, some of which is confusing. In this description an attempt has been made to clarify this by the following definitions:

Starch granule	— the starch storage organelle, consisting almost exclusively of regularly organised starch molecules giving a shape that is characteristic for the plant of origin;
Native starch	— a commercial raw material consisting primarily of purified starch granules in their natural state and not bound by parenchyma cell walls;
Starch cells	— the parenchyma cells containing native or gelatinised starch granules;
Gelatinised starch	— a raw material made from native starch or a raw material containing starch granules in which virtually all the starch granules have been physically modified to disrupt sufficiently the regular organisation of the starch molecules such that birefringence is lost;
Free gelatinised starch	— all the gelatinised starch not bound by parenchyma cell membranes.

The constraints imposed in the prior art include defined minimum levels of the native starch component (20%) and maximum levels for free gelatinised starch (20%) and for the pregelatinised starch ingredient (20%) in the mix.

These formulation constraints were imposed in order to achieve the desired half product and final product characteristics.

We have found it beneficial to use other formulations, in particular:

(a) formulations where the total starch component no longer exhibits birefringence and is a mixture of both free gelatinised starch and gelatinised starch contained within the starch cells (as defined above).

(b) formulations containing from 30% up to 100% of the total starch component in the form of free gelatinised starch.

(c) formulations in which there is less than 20% of ungelatinised native starch, together with gelatinised starch as in (a) or (b) above.

Additionally, the known art imposes restrictions on the processing conditions in order that the desired products can be made, and these restrictions affect the efficiency of the process.

Other techniques are known for producing snack products, involving, for example, the use of high temperature extrusion to gelatinise the starch granules with the subsequent production of the shaped product using conventional pasta techniques. This, however, requires specialist equipment that is not suited for the production of conventional pasta.

We have found that the changing tastes anticipated in the snack market have required the development of new product characteristics, and that these cannot be readily achieved within the constraints of the prior art and give a consistent product. This has important considerations with regard to the economics of the process including maintaining high throughput from the extruder for as long as is practically possible. Consistency is measured in terms of the uniformity of shape definition, product length, half product and final product bulk density, surface characteristics and shape retention on frying.

In our studies on the effects of salt concentrations we have found that the level is more critical than previously suggested. Whilst it may be desirable to operate within a preferred range of 3.0 - 4.0% we have found that as the salt level decreases, there is a near exponential fall in the degree of product expansion on frying such that, within the constraints of the prior art, expansion is inadequate below 2% and very little occurs below 1%. Conversely, whilst no additional expansion is attributable to increasing the ionic salt concentration to in excess of 4.0%, the upper limit is substantially governed by palatability. Where, however, part of the salt fraction is incorporated into one of the pregelatinised raw materials, it is thought to be chemically bound to the protein and this permits the use of higher levels than would be expected from a palatability point of view, e.g. up to 5.5%.

Additionally, we have found that the processing conditions given for making snack products and half products on pasta manufacturing equipment do not define sufficiently the required operating parameters to ensure product consistency. These can cause a lack of dough uniformity, leading to a variable end product.

Statement of invention

According to the present invention there is provided a process for making starch-based foodstuffs or half products therefor in which,

(a) the total starch component of the formulation no longer exhibits birefringence and is a mixture of both free gelatinised starch and gelatinised starch (as herein defined) contained within the starch cells; or

(b) the formulation contains from 30% to 100% of the total starch component in the form of free gelatinised starch; or

(c) the formulation containing less than 20% of ungelatinised native starch together with gelatinised starch as in (a) or (b) above; the formulation being extruded under pressure within the range 80 to 130 kg/cm^2 and with a pre-die temperature of 50°C to 70°C under conditions at which minimum gelatinisation of the native starch occurs.

Drawings

Figure 1 is a photomicrograph taken under polarised light of the compacted mix in the barrel of the extruder;

Figure 2 is a photomicrograph after iodine staining of the mix in the barrel of the extruder;

Figure 3 is a photomicrograph taken under polarised light of the mix within the cone of the extruder;

Figure 4 is a photomicrograph after iodine staining of the mix within the cone of the extruder; and

Figure 5 is a photomicrograph taken under polarised light of a transverse section of the extruded pellet showing that gelatinisation of the starch has not occurred even where it has been subjected to maximum shear.

Specific description

The apparatus by which the process of the present invention may be carried out comprises a dosing device by which predetermined quantities of the ingredients are deposited in a chamber for wet mixing prior to delivery of dough/crumb into the barrel of an extruder. The dough is fed through the barrel by a worm screw to a cone shaped pre-die chamber from which it is extruded through a die. The downstream end of the extrusion barrel is enclosed within a temperature controlled water jacket. Associated with the die is a rotary cutter which cuts the dough as it is extruded, the cut pieces falling into the drier.

It has been our experience that the more severe the conditions, in an attempt to achieve gelatinisation of the raw starch, the greater is the instability of the process and the more variable the product with respect to shape and bulk density. Consequently, it is a specific feature of the present invention that no attempt is made at gelatinising the starch, nor to damage the parenchyma cell walls containing gelatinised starch, in the process. During the extrusion process there will be a progressive heat gain by the dough from the low pressure end of the extrusion worm, up to the high pressure end and in particular immediately prior to the die. Due to the heat gain in the dough, the half product on extrusion shows translucency. This is not due to gelatinisation but is thought to be a phase change. Reference to the photomicrographs of Figures 1 to 4 clearly shows that no loss of birefringence occurs at the point of maximum heat gain prior to extrusion, by applying the preferred process conditions. The apparent increase in proportion of starch exhibiting birefringence is a function of increasing dough compaction under higher pressure. Reference to the photomicrograph in Figure 5 taken under polarised light shows that gelatinisation of the starch has not occurred even where it has been subjected to maximum shear when extruded under the preferred conditions. The extrusion conditions would normally be a pre-die temperature of 50^c - 70°C, and a pressure of 80 - 130 kg/cm^2.

It has been found that the dough rheology may be changed through adjustment to the extrusion water jacket temperature thus maintaining steady temperature/pressure and improved product quality and the preferred jacket temperature would normally be 48 - 65°C.

Under conditions of, for example, a dough temperature of 75°C and a pressure of 150 kg/cm^2 as proposed by the prior art, it is to be expected that an unacceptable length variation of the pellet, and a rapidly falling extruder output, would occur. In addition the process control parameters would become erratic, with unpredictable response to a change; and the product on frying would lack consistency of quality.

We have found it to be beneficial to modify extrusion worms/heads to improve the dough homogeneity, which again leads to greater product consistency. This is considered to be an improvement on standard pasta manufacturing equipment.

With regard to the die type, we have found that aperture size is critical for any one shap . Die wear is directly related to the raw material type and the mode of processing, and the tolerances mor critical than with standard pasta manufacture.

Presented with this inability to manufacture the required products we have now developed a m thod of manufacturing snack half products which gives both an increased range of concepts and significant economic advantages.

By our proposals for the present invention we have found it possible, and advantageous, to manufacture snack products and half products with a wide range of characteristics using formulations containing much higher levels of gelatinised starch and free gelatinised starch than previously claimed using pasta manufacturing equipment that has been reversibly modified.

There now follows examples of how the process of the present invention may be applied commercially

(the percentages given being by weight):

Ex ımple 1 - Ingredients:

Gelatinised wheat flour	37.0%
Potato granules	50.0%
Gelatinised potato starch	10.0%
Salt	3.0%

The ingredients were dry blended and water at 45°C metered in, with continuous mixing, such as to hydrate the mix to a total of 28% moisture. Wet mixing was achieved within 10 minutes yielding a substantially uniform crumb, exhibiting even moisture distribution. The crumb was then worked in a pasta extruder to give the requisite dough rheology. A water jacket circulation temperature of 65°C was applied giving a pre-die temperature reading of 65°C and an extrusion pressure of 115 kg/cm^2. A "TEFLON" (Trade Mark) inserted "hoop" shaped die, having an aperture size of 0.85 mm., was utilised. Aperture sizes within the range 0.80 mm. to 1.20mm. may be used. The product was then cut by a flying blade and the pellet reduced to 9.0% moisture in a conventional pasta drier. On frying at 200°C for 11 seconds, a light textured snack resulted.

In this formulation, the potato granules consist of gelatinised starch contained within the starch cell; gelatinised wheat flour and potato starch are free, gelatinised starch.

The aforegoing example will be found to provide a selected balance of both free gelatinised starch and gelatinised starch contained within the starch cell, such that the total starch component no longer exhibits birefringence.

Example 2 - Ingredients:

Coloured gelatinised wheat flour	70.5%
Gelatinised potato starch	16.0%
Gelatinised wheat flour	10.0%
Salt	3.5%

The processing of a noodle pellet is similar to that given for Example 1 but the parameters included a mix moisture of 33%, a water temperature of 45°C, jacket temperature of 50°C, pressure 110 kg/cm^2, and a pre-die temperature of 59°C.

In this formulation, all the starch is in a free, gelatinised state so that the selected balance of raw materials is one in which the total starch component is in the form of free gelatinised starch.

Example 3 - Ingredients:

Gelatinised wholewheat flour	50.0%
Gelatinised wheat flour	10.0%
Gelatinised potato starch	10.0%
Potato starch	20.0%
Wholewheat semolina	7.0%
Salt	3.0%

The processing of a square pellet is similar to that given for the previous examples but the parameters included a mix moisture of 31%, a water temperature of 50°C, jacket temperature of 55°C, pressure 120 kg/cm^2, and a pre-die temperature of 60°C.

In this formulation, more than 30% (but less than 100%) of the total starch component is in the form of free gelatinised starch.

Example 4 - Ingredients:

Gelatinised wholewheat semolina	60.0%
Potato granules	10.0%
Gelatinised potato starch	10.0%
Wholewheat semolina	7.0%
Potato starch	10.0%
Salt	3.0%

The processing for a tube pellet ıs similar to that given f r the previous xamples but the paramet rs included a mix moisture of 34%, a water temperatur of 59°C, pr ssure of 85 kg/cm^2, and a pre-die temperature of 61°C.

In this formulation the potato starch and wholewheat semolina contain raw, native starch and there is less

than 20% of ungelatinised native starch, together with gelatinised starch as in Exampl 1 and 2.

CLAIMS

1. A process for making starch-based foodstuffs or half products therefor from a formulation in which:

(a) the total starch component of the formulation no longer exhibits birefringence and is a mixture of both free gelatinised starch (as herein defined), and gelatinised starch (as herein defined) contained within the starch cells; or

(b) the formulation contains from 30% to 100% of the total starch component in the form of free gelatinised starch; or

(c) the formulation contains less than 20% of ungelatinised native starch together with gelatinised starch as in (a) or (b) above;

the formulation being extruded under pressure within the range 80 to 130 kg/cm^2 and with a pre-die temperature of 50° to 70°C under conditions at which minimum gelatinisation of the native starch occurs.

2. A process for making starch-based foodstuffs or half products therefor as claimed in Claim 1, in which the pre-die temperature of the extruder is from 50° to 70°C.

3. A process for making starch-based foodstuffs or half products therefor as claimed in either Claim 1 or Claim 2 in which the die has an aperture size within the range 0.80 to 1.20 mm.

4. A process for making starch-based foodstuffs or half products therefor as claimed in any one of the preceding claims, in which before extrusion the formulation has a moisture content between 25 to 35% and after extrusion the moisture content is reduced to between 9% to 11%.

5. A process for making starch-based foodstuffs or half products therefor substantially as herein described with reference to any one of the examples herein.

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